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DETERMINATION OF CRES 301 STRESS STRAIN CURVES INCLUDING THE PLASTIC REGION

7 E 2173

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REVISIONS

NO.	DATE	BY	CHANGE	PAGES AFFECTED

TABLE OF CONTENTS

DETERMINATION OF CRES 301 STRESS STRAIN CURVES

INCLUDING THE PLASTIC REGION

OBJECTIVE

To determine the tensile and compressive stress strain curves to ultimate of CRES 301 materials of hardnesses varying from 1/4 hard to extra full hard.

CONCLUSIONS

It is possible to obtain both the tensile and compressive properties in the plastic region by using an S-4 extensometer.

SPECIMENS

The tensile specimens were the standard 9 inch coupons machined according to Structural Standard 001 (See Figure 19).

The compression specimens were made from material of the same heat and coil as the tensile specimens and were made according to the "Cylinder Method"[1]; i.e., stainless steel rolled into cylinders 2 inches in length with a diameter of 0.80 inch. The Cylinder Method could only be used when the slenderness ratio was under 15 and the diameter-to-thickness ratio did not greatly exceed 40. The ends of the cylinders were machined and ground parallel to within an accuracy of ± 0.0002 inch (See Figure 20).

PROCEDURE

The longitudinal tensile specimens were tested on a 200,000 lb. Tinius Olsen Testing Machine at a strain rate of 0.005 in/in/min to the yield point, then increased to 0.15 in/min until failure. The transverse tensile specimens were tested on a 12,000 lb. Tinius Olsen Testing Machine at Plant I, San Diego Division.

PROCEDURE (Cont'd.)

The compression specimens were tested at a strain rate of 0.005 in/in/min to failure. An S-4 extensometer was used to obtain a load vs. strain curve.

It should be noted that for the 3/4 hard, 1/2 hard, and 1/4 hard materials in tension, it was necessary to reset the extensometer in order to record the complete strain in the plastic region. To ascertain the amount of strain lost while resetting the extensometer, the strain per unit time was determined just prior to the resetting. Then the length of time to reset the extensometer was determined and this amount of strain was added to the results.

RESULTS

A general summary of the results may be found in Table I.

In the longitudinal tensile specimens, the ultimate stress varied from 160 ksi for the 1/4 hard material to 220 ksi for the extra full hard material. The increase in strength sacrificed ductility as the average strain at failure varied from 0.424 in/in for the 1/4 hard material to 0.099 in/in for the extra full hard material (See Figures 1—6).

A comparison of the compressive properties of ultimate stress and strain at failure are shown in Figures 7 and 8.

Figures 9 through 13 show a comparison of the compressive properties of each hardness according to the direction of rolling of the material.

Figures 14 through 18 compare the longitudinal tensile and compressive properties of the various hardnesses and show that in each case, the ultimate stress in tension is greater than in compression.

BIBLIOGRAPHY

1. Franks, R. and Binder, W. O.,
"The Stress Strain Characteristics of Cold Rolled Austenitic Stainless Steels in Compression as Determined by the Cylinder Test Method", Proceedings of the American Society for Testing Materials, Vol. 41, 1941, Page 629.

TABLE I

TENSILE AND COMPRESSION AVERAGES OF CRES 301 MATERIAL

Hardness of Material	Physical Properties	TYPE OF SPECIMEN			
		Longitudinal Tensile	Transverse Tensile	Longitudinal Compression	Transverse Compression
Extra Full Hard CVA 0-71004	% Elongation	5.4	6.5	—	—
	Yield Stress, ksi	204.0	192.2	—	—
	Ult. Stress, ksi	219.9	224.8	190.4	233.6
	Strain at Failure, in/in	0.0994	—	0.0184	0.0190
Full Hard CVA 0-7[illegible]003	% Elongation	16.4	10.5	—	—
	Yield Stress, ksi	183.9	160.5	—	—
	Ult. Stress, ksi	199.0	206.3	176.6	202.0
	Strain at Failure, in/in	0.183	—	0.0168	0.0141
3/4 Hard CVA 0-71005	% Elongation	23.2	21.1	—	—
	Yield Stress, ksi	155.2	139.6	—	—
	Ult. Stress, ksi	171.1	173.9	155.4	181.2
	Strain at Failure, in/in	0.222	—	0.0171	0.0132
1/2 Hard MIL-S-5059A	% Elongation	32.2	25.6	—	—
	Yield Stress, ksi	125.3	110.2	—	—
	Ult. Stress, ksi	175.7	175.6	141.9	155.9
	Strain at Failure, in/in	0.368	—	0.0171	0.0127
1/4 Hard MIL-S-5059A	% Elongation	44.0	44.3	—	—
	Yield Stress, ksi	98.7	95.1	—	—
	Ult. Stress, ksi	159.7	153.4	110.8	124.5
	Strain at Failure, in/in	0.424	—	0.0172	0.0117

AVERAGE CURVES OF VARIOUS HARDNESSES OF CRES 301 LONGITUDINAL MATERIAL - 7E 2173

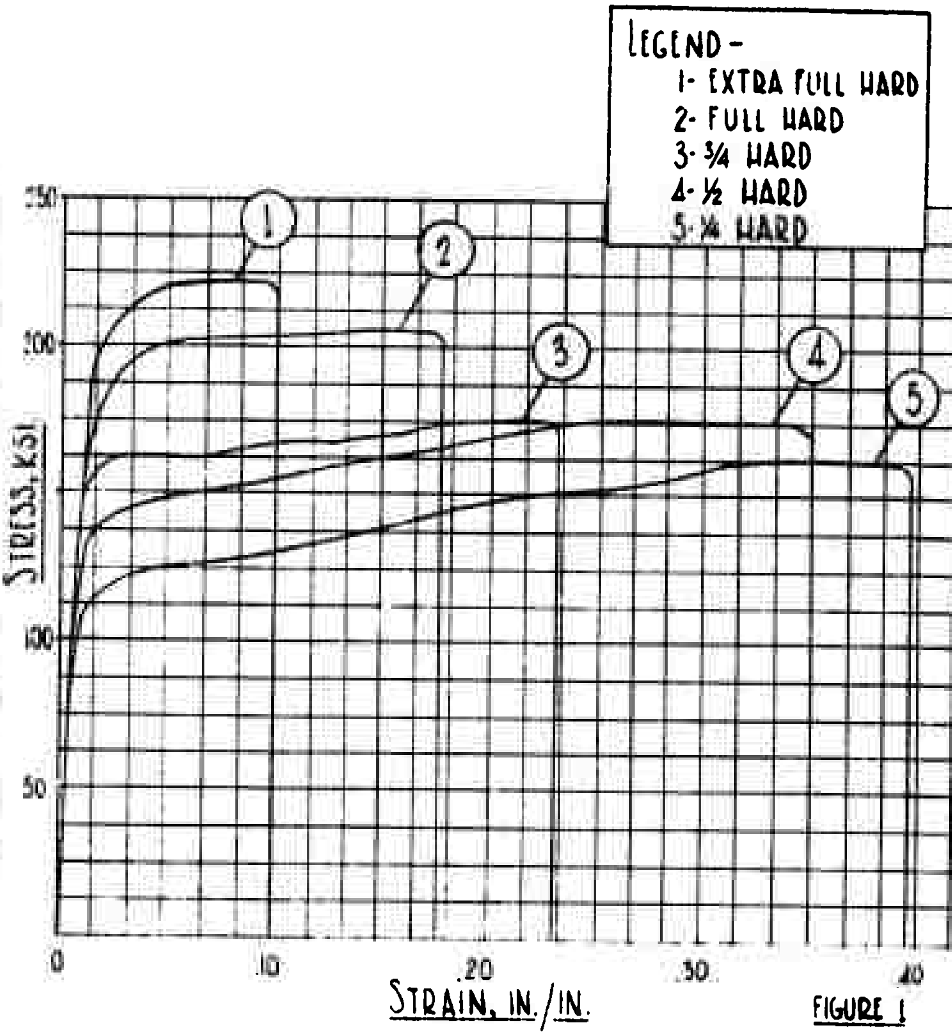

FIGURE 1

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

STRESS VS STRAIN
AVE. OF CRES 301 XFH
0-71004 7E2173

LONGITUDINAL

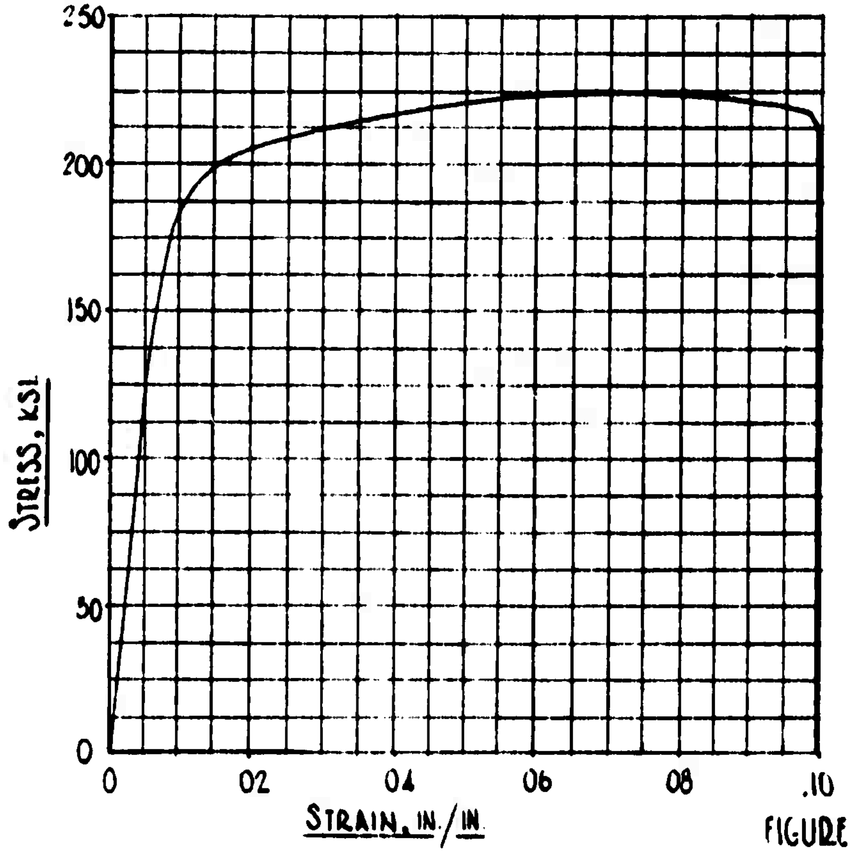

FIGURE 2

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

STRESS VS STRAIN
AVE. OF CRES 301 FH
7E 2173 LONG.

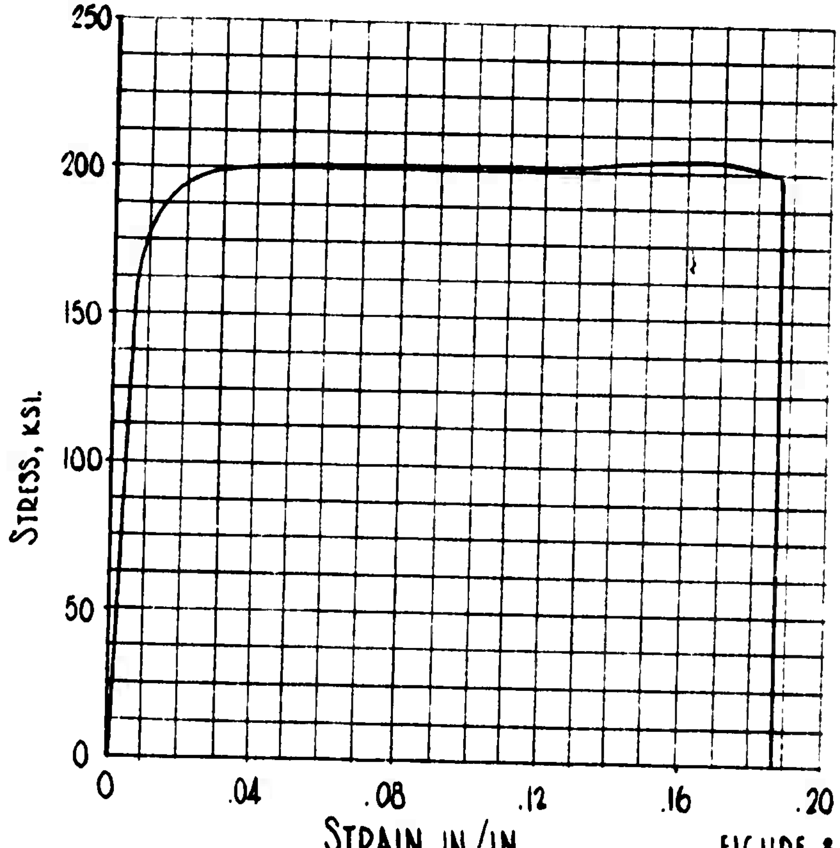

FIGURE 3

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

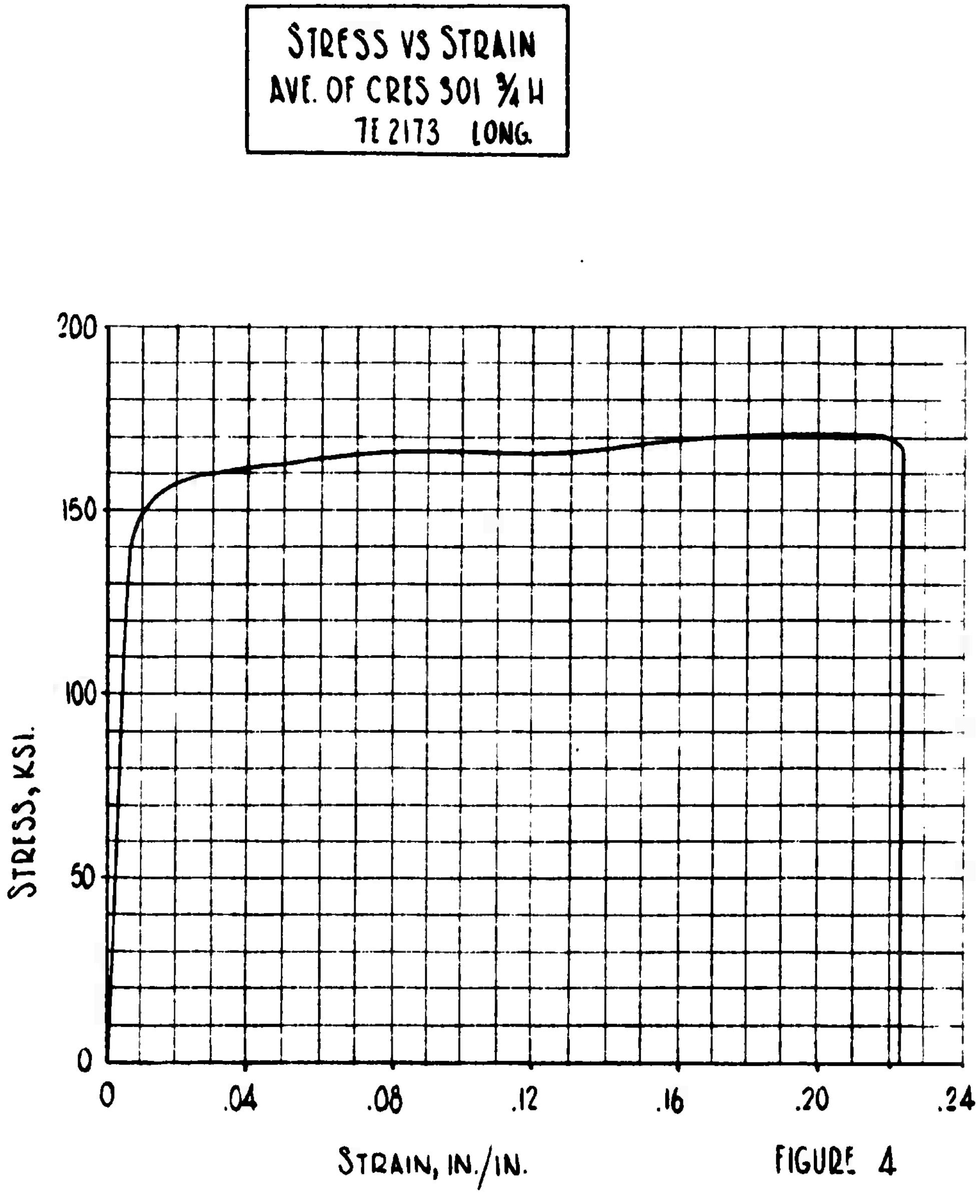
STRESS VS STRAIN
AVE. OF CRES 301 ¾ H
7E 2173 LONG.
STRESS, KSI.
200
150
100
50
0
0
.04
.08
.12
.16
.20
.24
STRAIN, IN./IN.

FIGURE 4

STRESS VS STRAIN
AVE. OF CRES 301 ½ H
7E 2173 LONG.

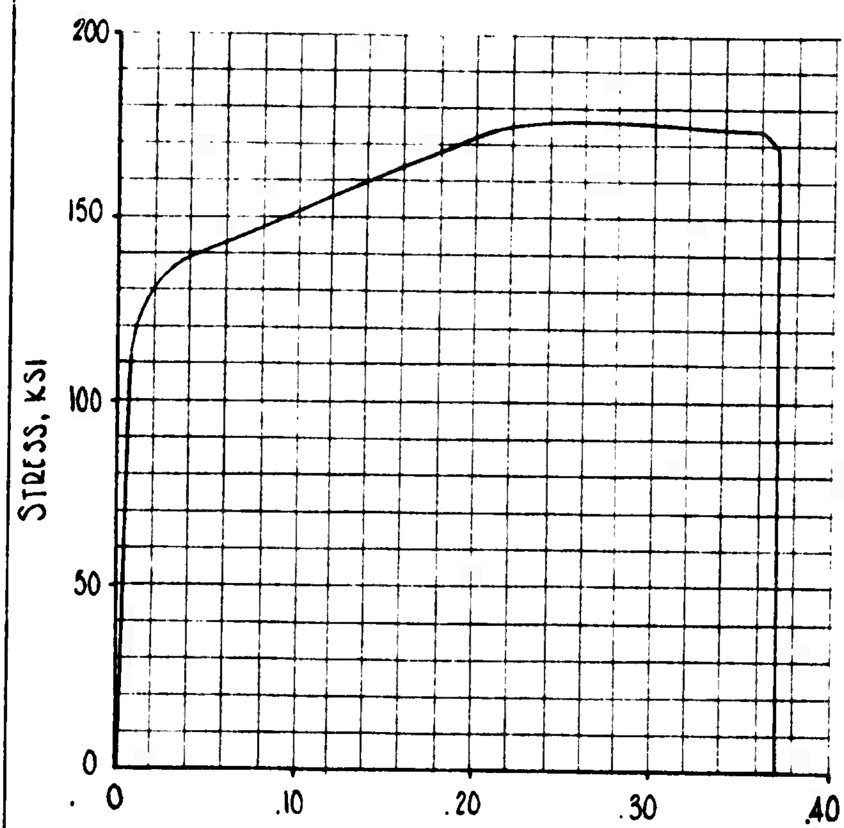

FIGURE 5

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

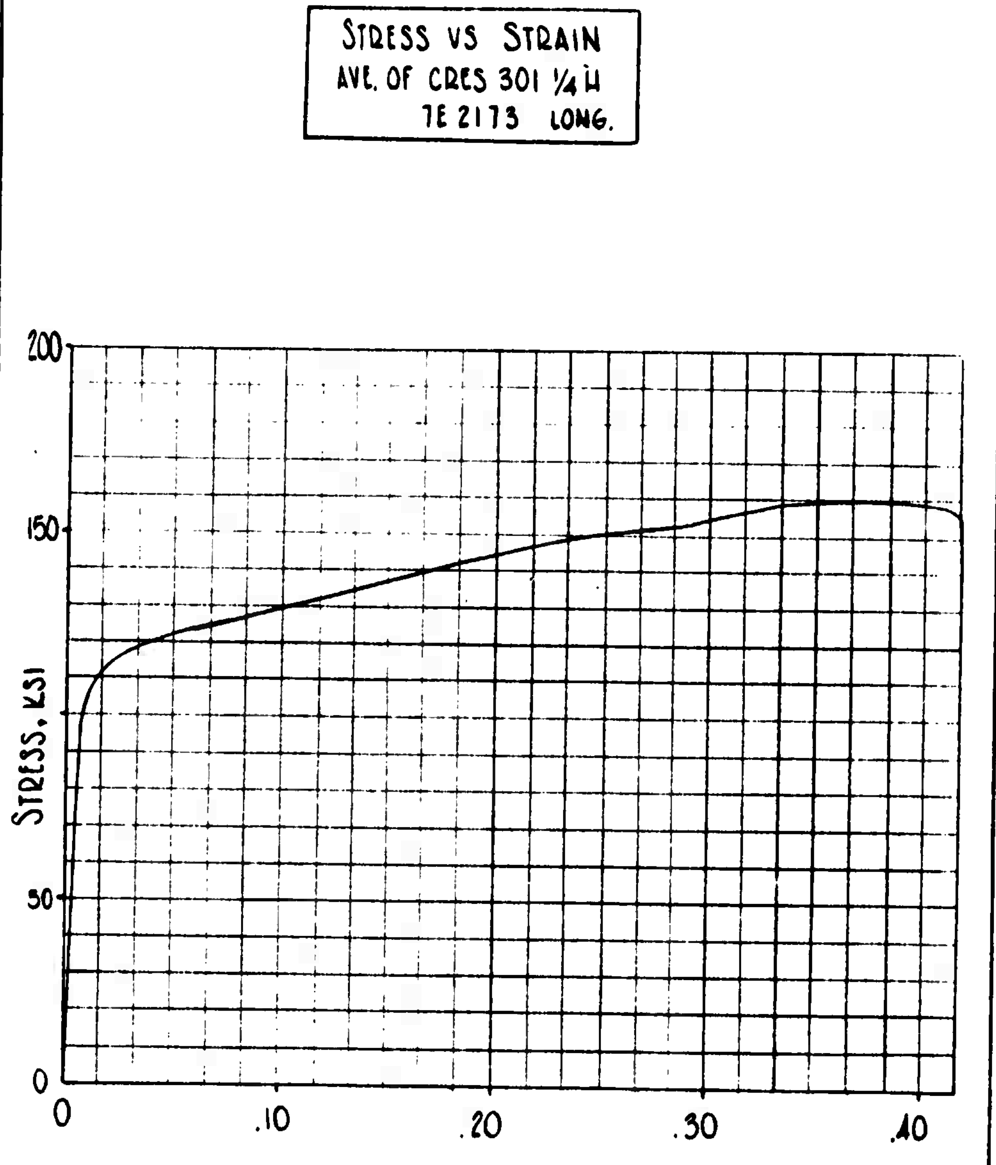

FIGURE 6

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

AVERAGE CURVES OF VARIOUS HARDNESSES IN COMPRESSION
CRES 301 TRANSVERSE 7E 2173

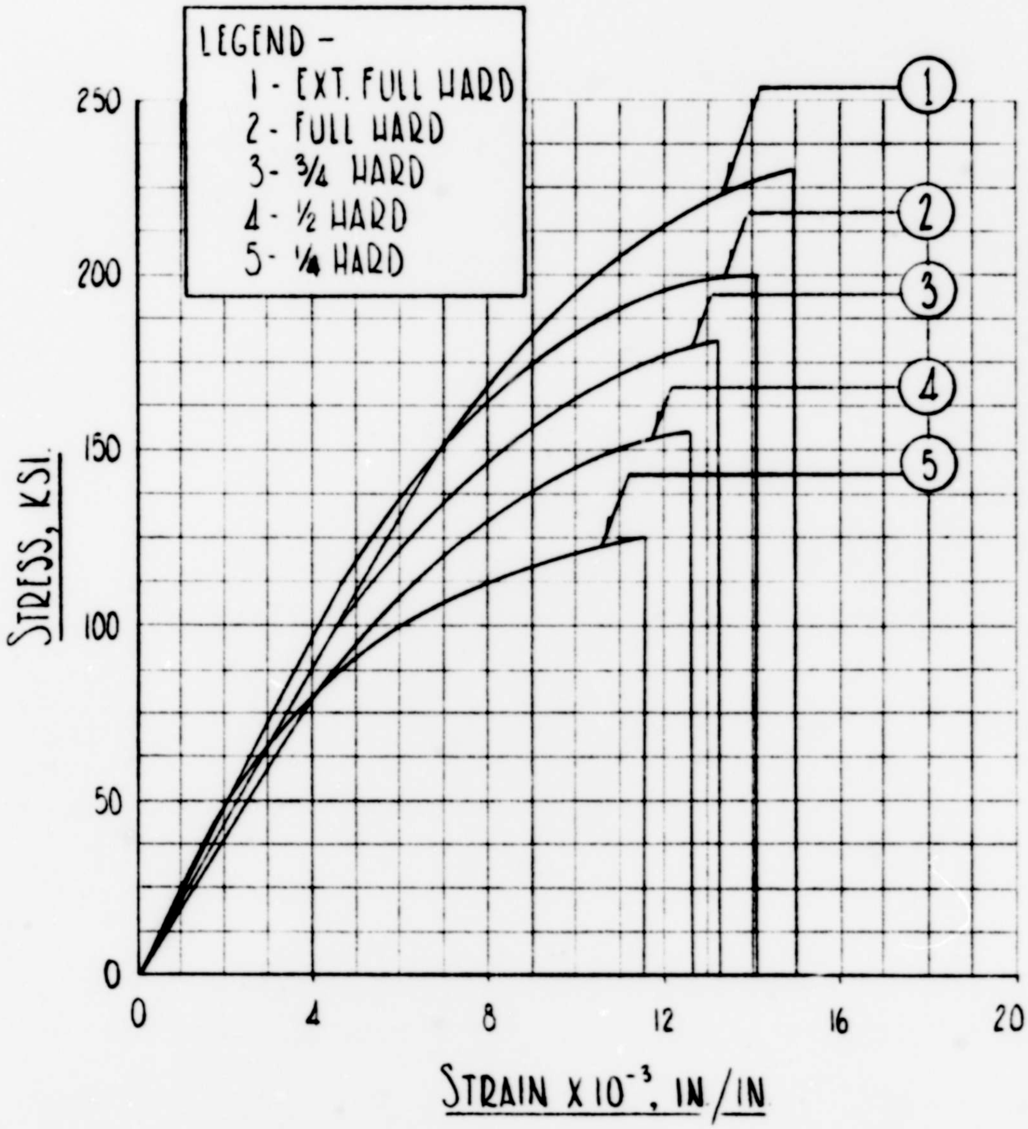

FIGURE 7

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

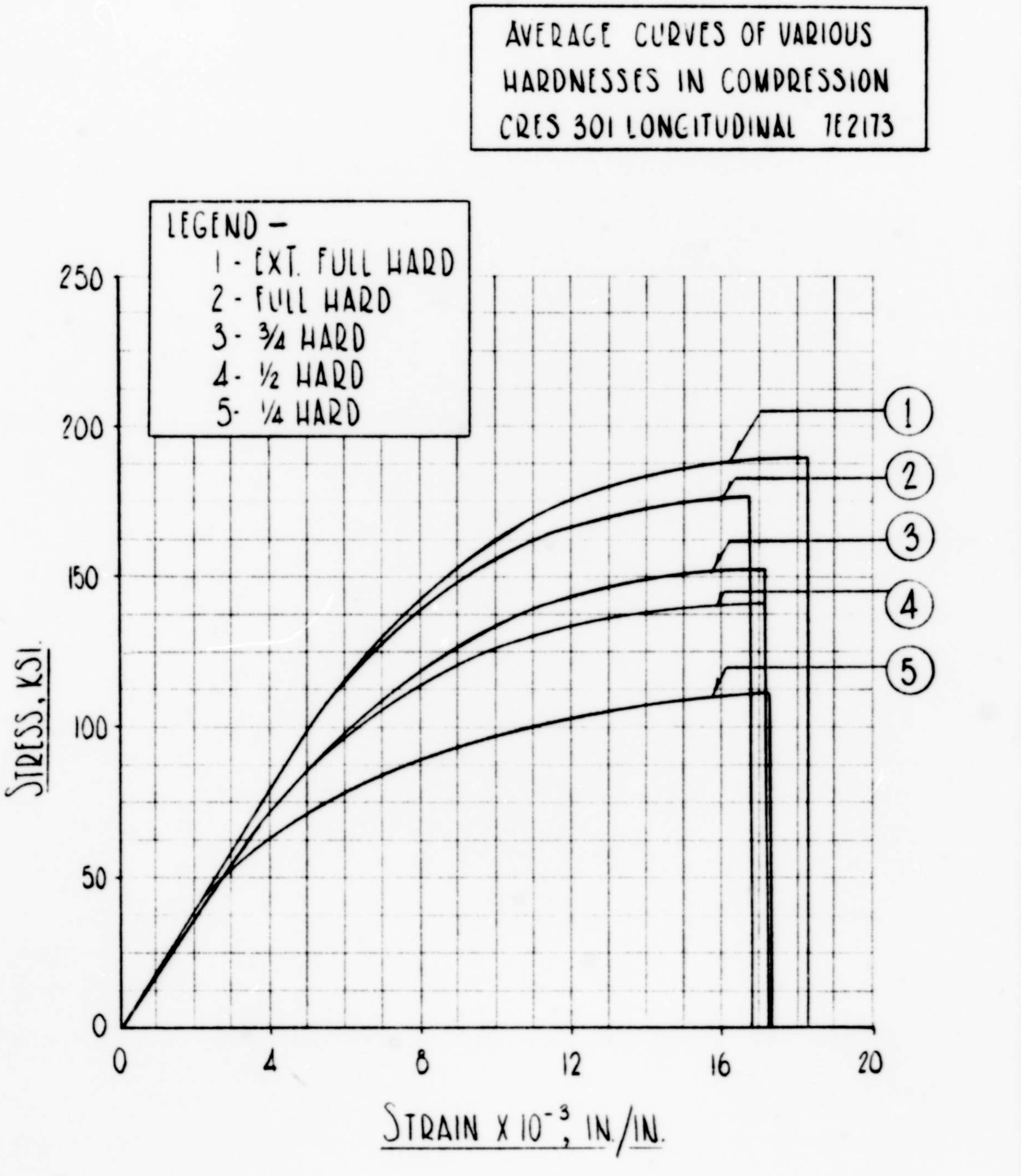

FIGURE 8

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

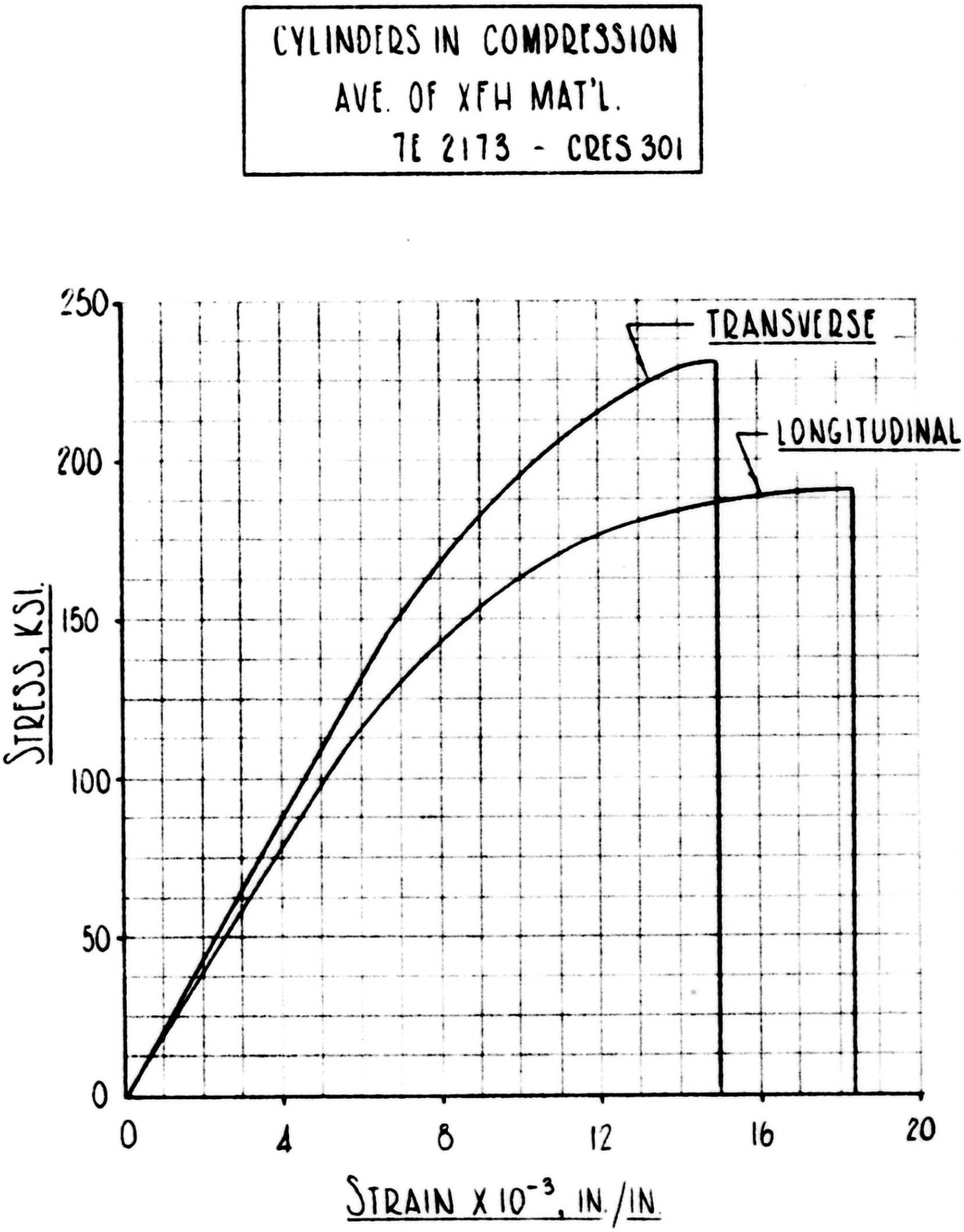
CYLINDERS IN COMPRESSION
AVE. OF XFH MAT'L.
7E 2173 - CRES 301
TRANSVERSE
LONGITUDINAL
STRESS, KSI.
0
50
100
150
200
250
0
4
8
12
16
20
STRAIN X 10^{-3}, IN./IN.

FIGURE 9

CYLINDERS IN COMPRESSION
AVE. OF F.H. MAT'L.
7E2173 CRES 301

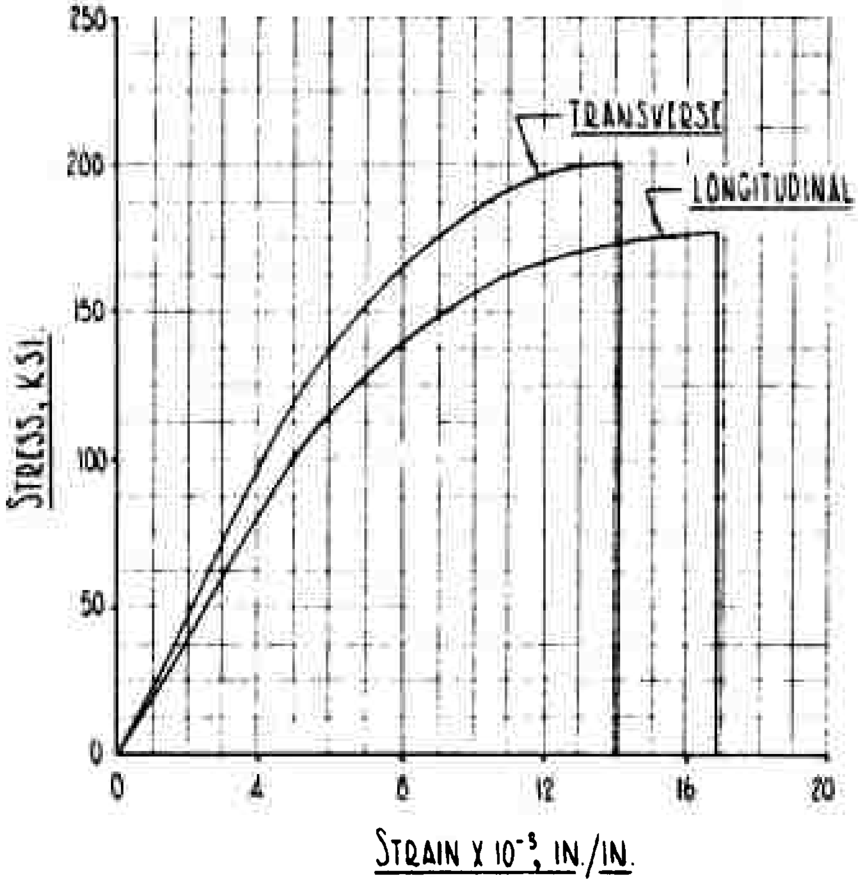

FIGURE 10

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

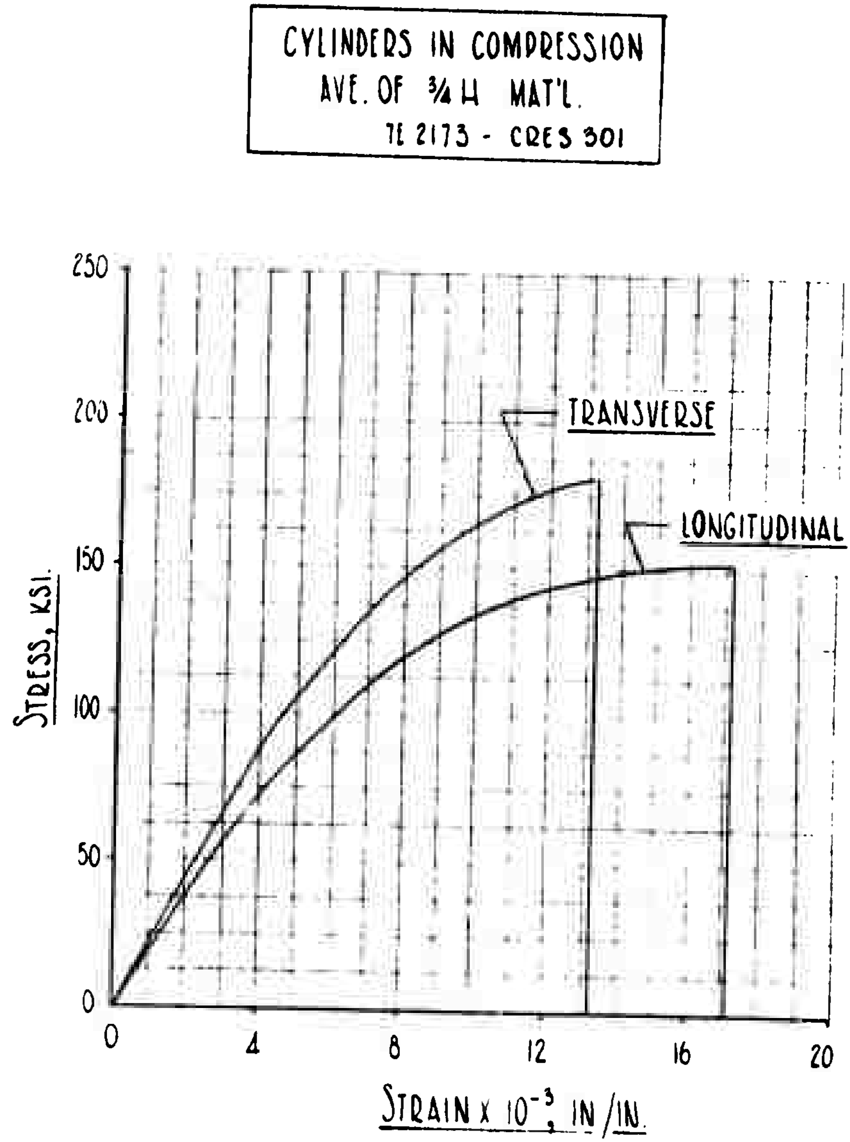
CYLINDERS IN COMPRESSION
AVE. OF ¾ H MAT'L.
7E 2173 - CRES 301
TRANSVERSE
LONGITUDINAL
STRESS, KSI.
250
200
150
100
50
0
0
4
8
12
16
20
STRAIN x 10⁻³, IN/IN.

FIGURE 11

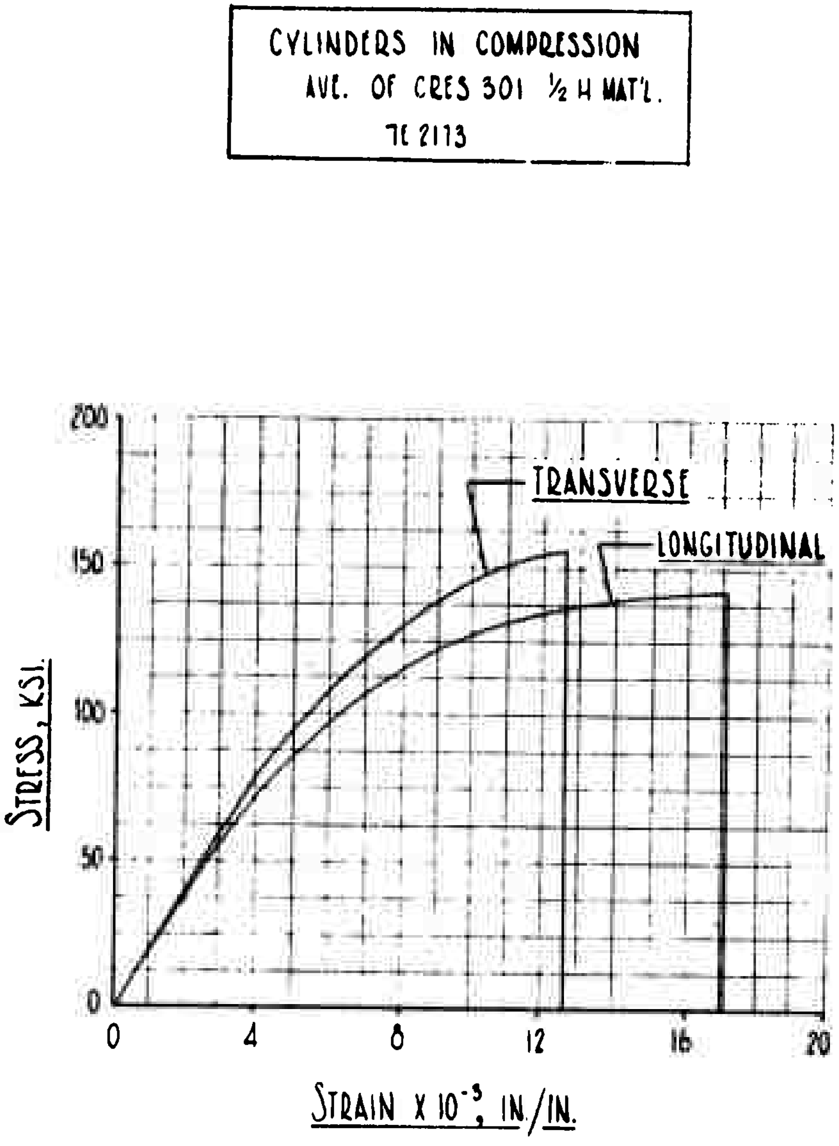
CYLINDERS IN COMPRESSION
AVE. OF CRES 301 ½ H MAT'L.
7E 2173
TRANSVERSE
LONGITUDINAL
STRESS, KSI.
200
150
100
50
0
0
4
8
12
16
20
STRAIN X 10^{-3}, IN./IN.

FIGURE 12

CYLINDERS IN COMPRESSION
AVE. OF CRES 301 ¼ H MAT'L.
7E 2173

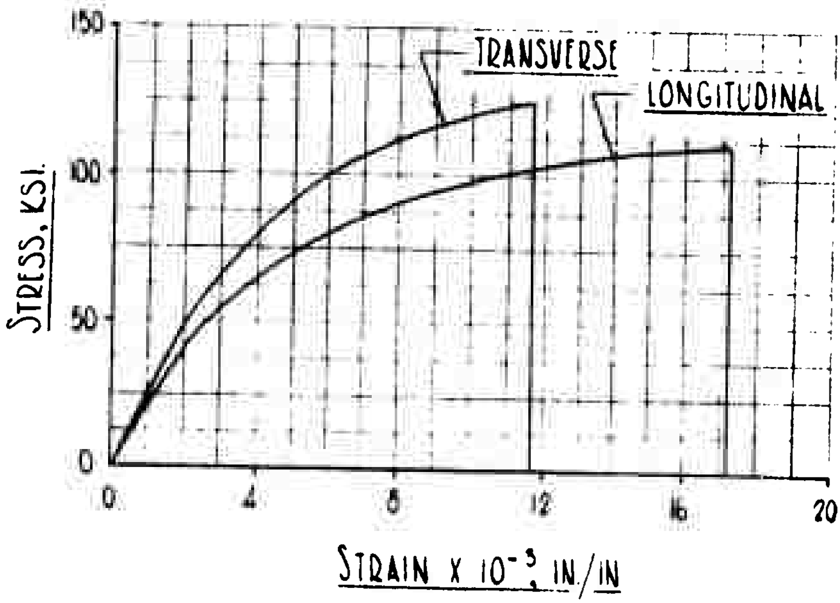

FIGURE 13

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

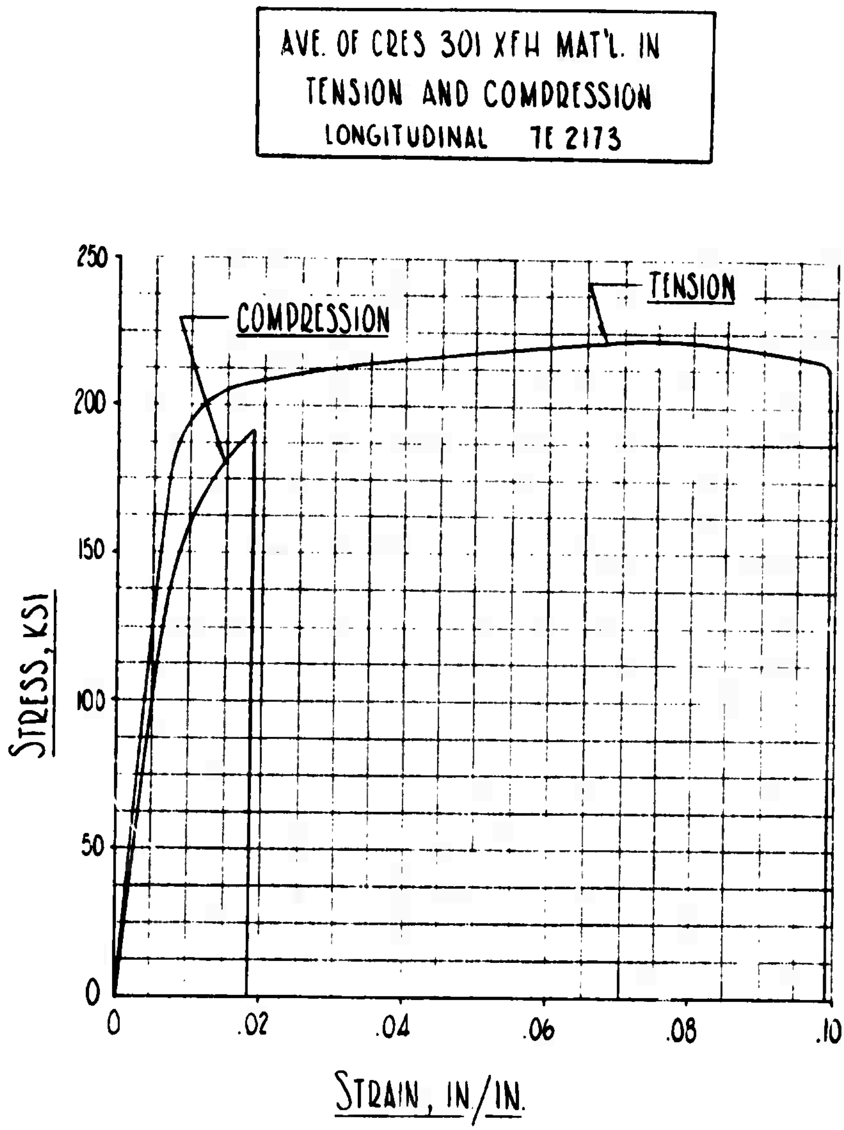
AVE. OF CRES 301 XFH MAT'L. IN
TENSION AND COMPRESSION
LONGITUDINAL 7E 2173
COMPRESSION
TENSION
250
200
150
100
50
0
STRESS, KSI
0
.02
.04
.06
.08
.10
STRAIN, IN/IN.

FIGURE 14

AVE. OF CRES 301 FH MAT'L. IN
TENSION AND COMPRESSION
LONGITUDINAL 7E 2173

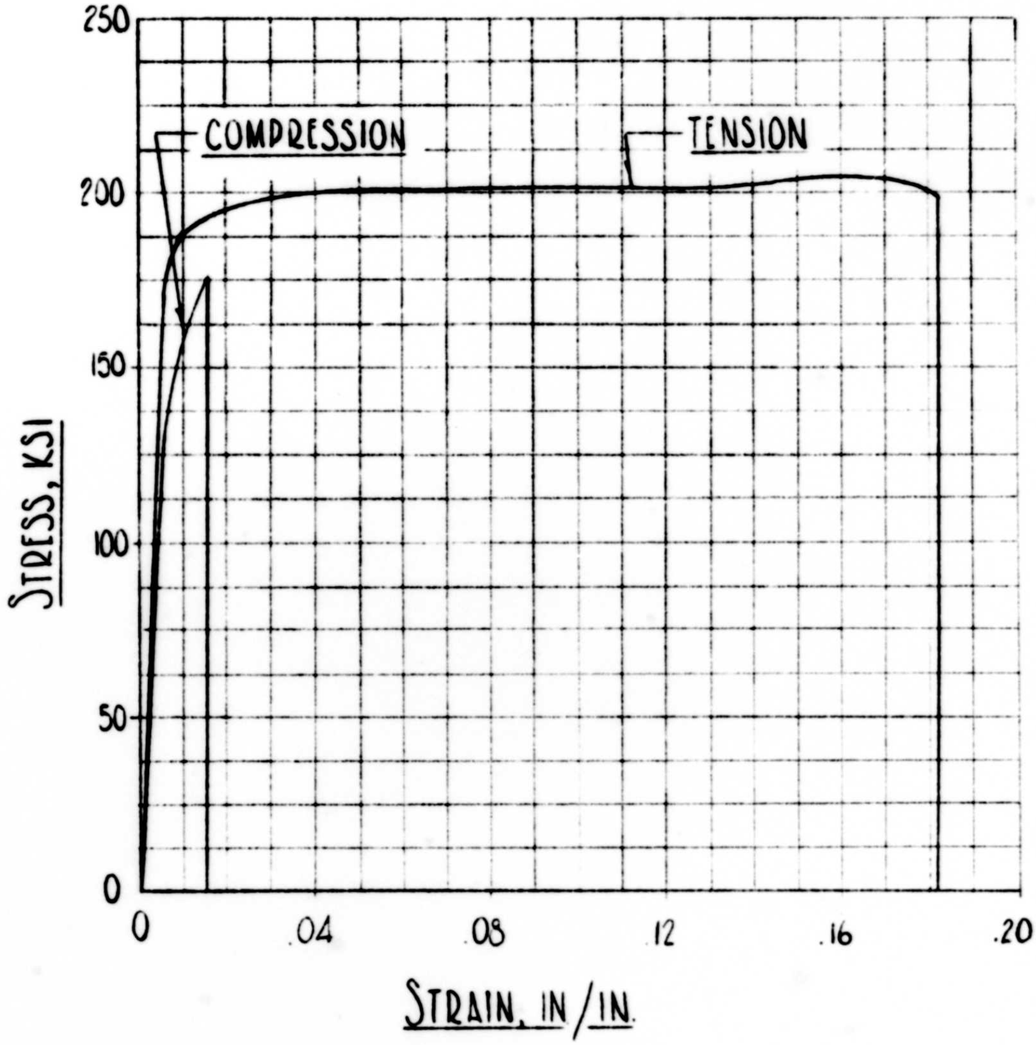

FIGURE 15

AVE. OF CRES 301 3/4 H MAT'L. IN
TENSION AND COMPRESSION
LONGITUDINAL 7E 2173

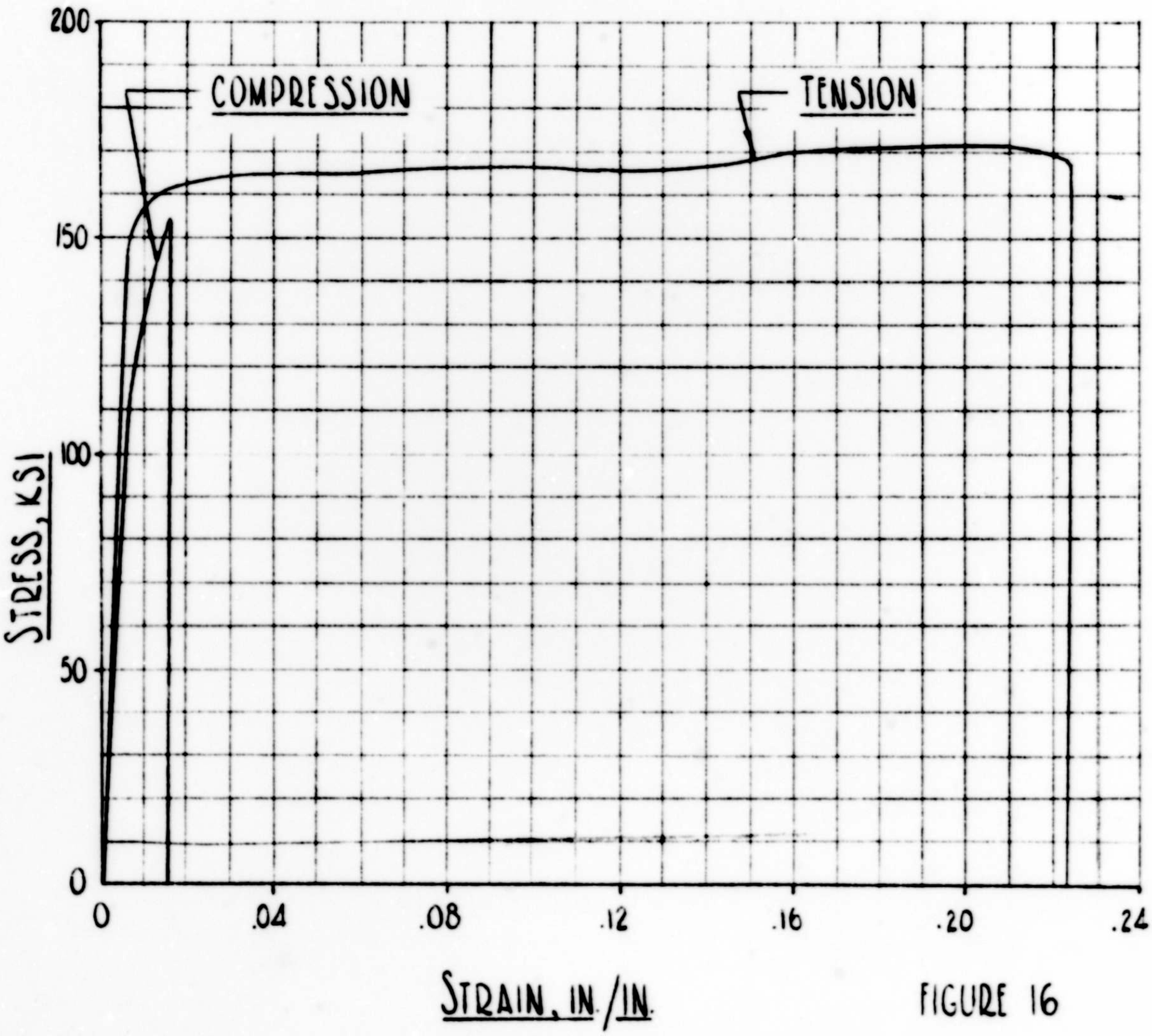

FIGURE 16

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

AVE. OF CRES 301 ½ H MAT'L. IN TENSION AND COMPRESSION LONGITUDINAL 7E 2173

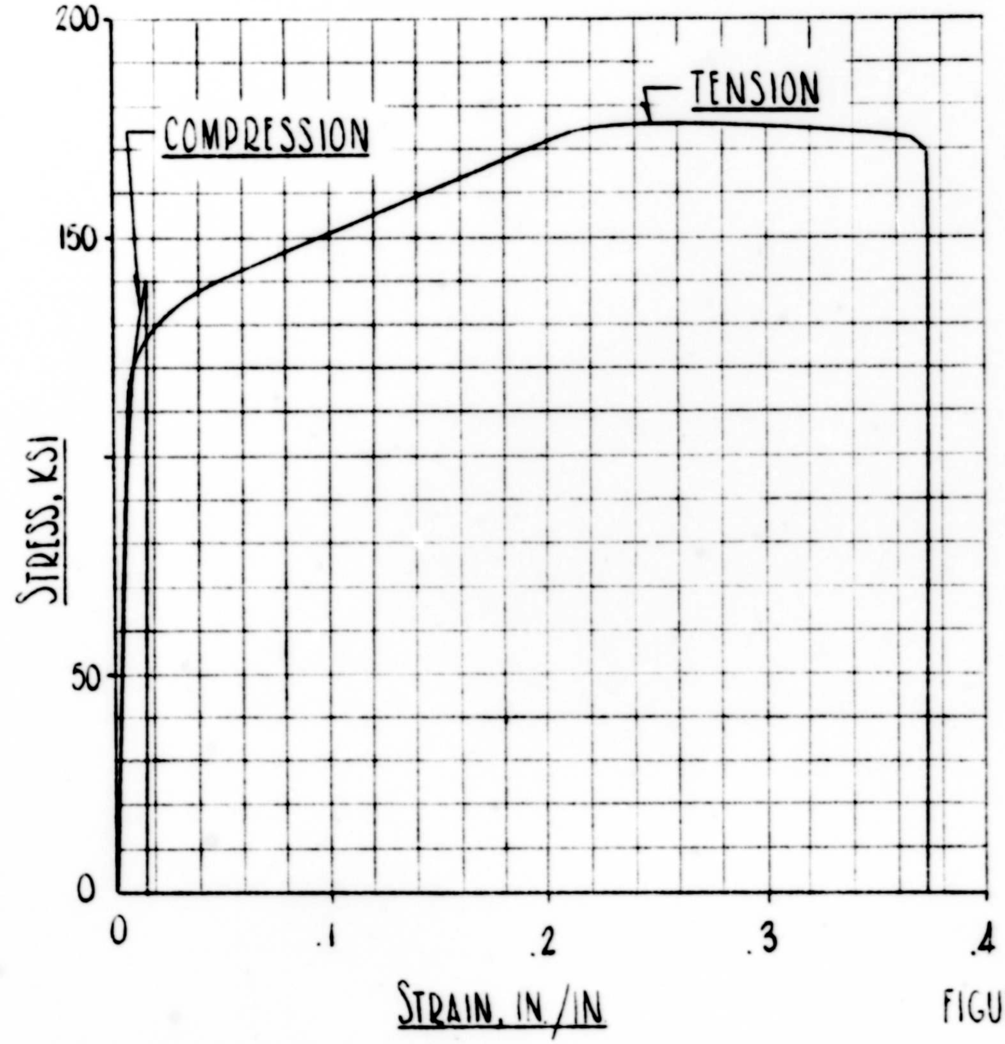

FIGURE 17

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

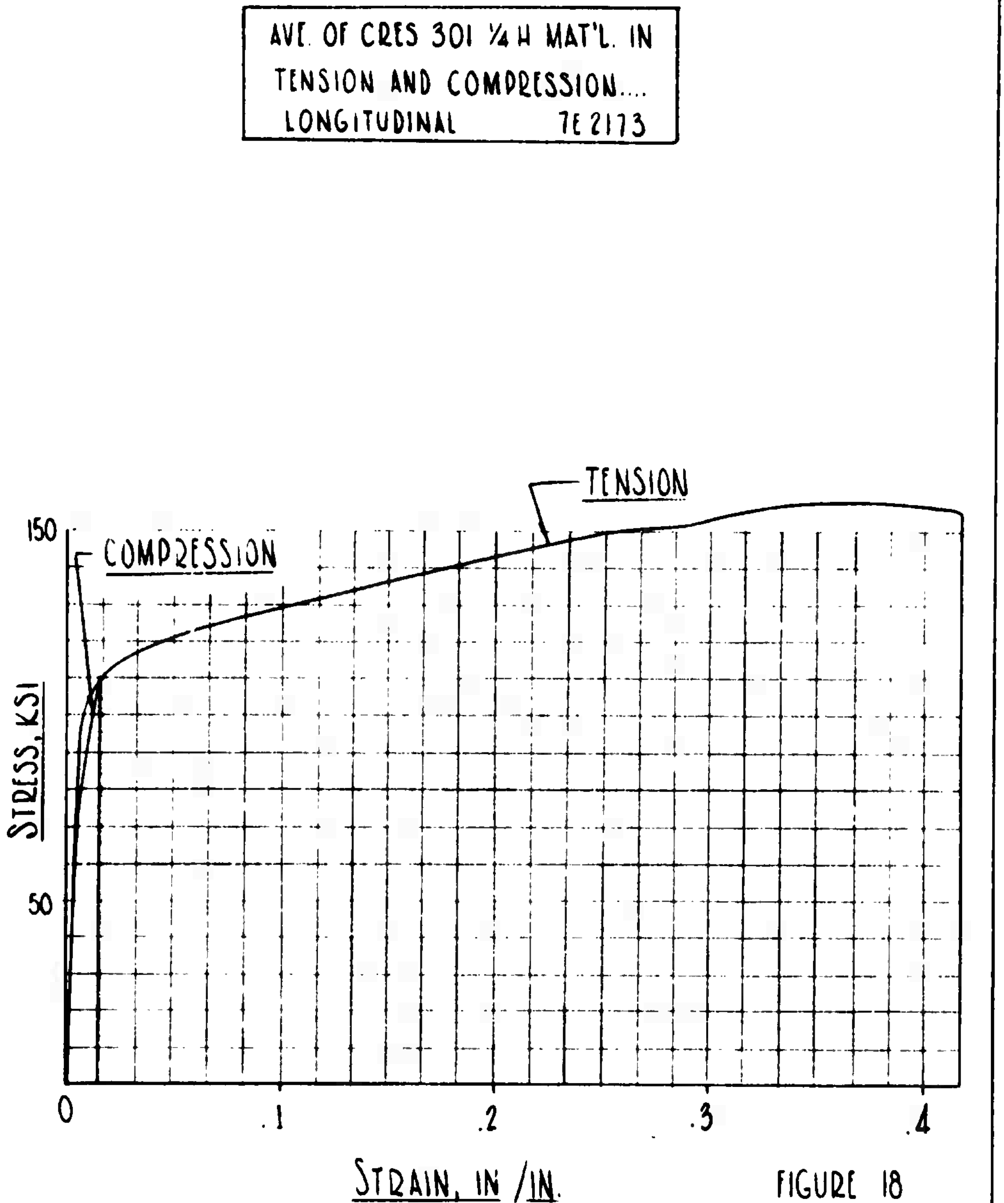

FIGURE 18

PREPARED BY	DATE	CHECKED BY	DATE	REVISED BY	DATE

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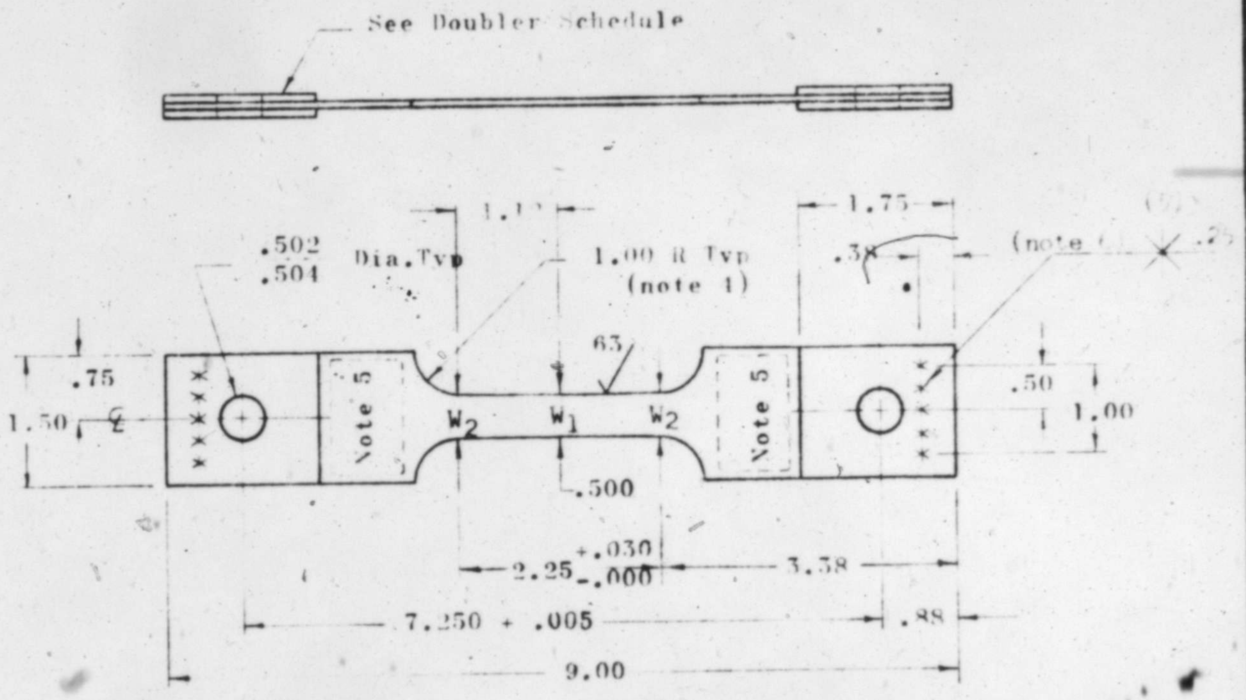
EFF ON	INCORP #	SYM	DESCRIPTION	DATE
		A	Changed double schedulé ".030 and over = same as sheet thickness" to .030 to .050 = .037, .050 and over = .050"	9-2[illegible]



NOTES

1. Holes on centerline of test section within + .005.

2. Gradual taper from W_2 to W_1 of .004 + .001 in. W_2 to be greater than W_1.

3. Test section to have sharp corners free from burrs.

4. No undercut at intersection of radius and test section.

5. Identify here by electro etch with Heat No., Coil No. Specification No., and Specimen No.

6. Spot weld per MIL-W-6858A.

DOUBLER SCHEDULE

Sheet Thick.	Minimum Doubler Thick.
Up to .030	.025
.030 to .050	.037
.050 and over	.050

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES ON

.XX	.XXX	ANGLES
±.03	±.010	±0°30'

STD
GR. R S Shorey 3/14/59
DRF Bill Rush 3/14/59

SPECIFICATION ~~CONTROL~~ DRAWING

SHEET MATERIAL TENSILE COUPON STANDARD

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SHEET 1 OF 1
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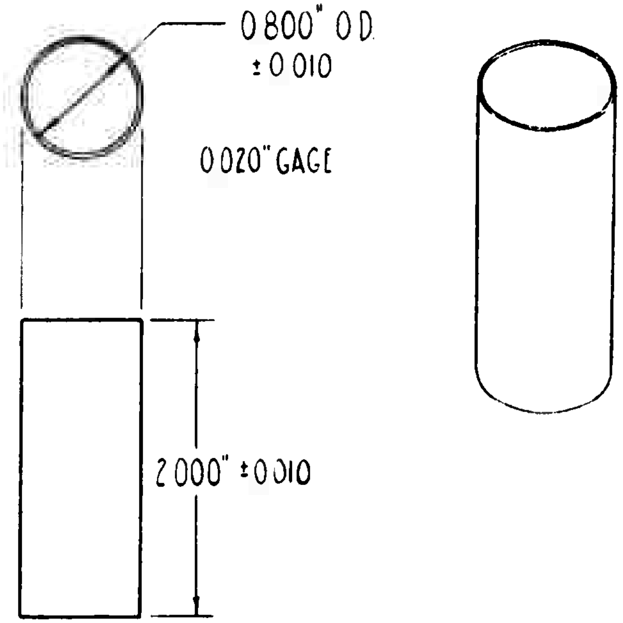
FORM A-414

Fig. 19



CYLINDER COMPRESSION SPECIMEN

FIGURE 20